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Three alien bark and ambrosia beetles (Coleoptera, Curculionidae, Scolytinae) new to Switzerland

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Abstract

Identifying alien species is important to ensure the early detection of biological invasions and survey shifts in species distributions in the context of global change. Here, we report on three alien bark and ambrosia beetles newly detected in Switzerland: *Cyclorhipidion distinguendum* (Eggers, 1930), *C. pelliculosum* (Eichhoff, 1878), and *Hypothenemus eruditus* (Westwood, 1834). These species were recorded for the first time during a comprehensive survey of saproxylic beetles accross major forest types and along an altitudinal gradient during the entire growing season in the southern Alps, in the canton of Ticino. Their local abundance and number of occurrences accross different lowland forest habitats, including alluvial forests of national importance, indicates that all three species are already naturalized. Given their polyphagy, it is likely that all three species will become more extensively distributed across Switzerland, with a yet unknown environmental impact.

Key Words

Alien species, biological invasions, distribution, first record, faunistics, introduction, *Cyclorhipidion*, *Hypothenemus*

Introduction

The distributions of organisms are changing at fast rates worldwide (e.g., Pereira et al. 2010), a phenomenon amplified by globalization and the acceleration in trade, which increase the number of alien species across the world (Seebens et al. 2017). The correct identification of new arrivals is important to conduct risk assessments of potential pest organisms at an early stage of invasion and in general to elucidate shifts in species ranges in the context of global change (e.g., Blackburn et al. 2011; Simberloff et al. 2013; Hawkins et al. 2015).

Wood-boring insects are among the invasive species with the greatest ecological and economic impacts (Aukema et al. 2011) and their introduction pathways are generally well known (Essl et al. 2015): they are frequently introduced with wood packing materials used in international trade (Brockerhoff et al. 2006; Kirkendall and Faccoli 2010; Inward 2020), a trend that seems to be constantly increasing (Hulme et al. 2009; Lantschner et al. 2020). Moreover, since these species often come from warm regions, this increase is likely favoured by climate change (Pureswaran et al. 2022). In Europe, more than 30 species of exotic Scolytinae are currently known

(Kirkendall and Faccoli 2010; Sauvard et al. 2010; Barnouin et al. 2020; Marchioro et al. 2022) and these often originate from Asia (Kirkendall and Faccoli 2010; Roques et al. 2020; OFEV 2022).

Xyleborine ambrosia beetles (Coleoptera, Curculionidae, Scolytinae) are species depending on the presence of symbiotic fungi in the larval galleries of their host plants for larval and adult nutrition. The fungi are carried by adults females via their spores in adapted organs, the mycangia, and deposited in the larval galleries of their new hosts (Batra 1963; Beaver 1989; Mayers et al. 2022). The rapid colonization of new territories is facilitated by their high reproductive success: most ambrosia beetles are inbreeding, reproduce by sib-mating, and have a sex ratio strongly biased towards females (Kirkendall and Ødegaard 2007; Kirkendall and Faccoli 2010; Vega et al. 2015). Moreover, their marked host plant polyphagy favours a rapid adaptation to new environments. This is the case, for example, of *Xylosandrus germanus* (Blandford, 1894) and *Cyclorhipidion bodoanum* (Reitter, 1913), two species that have rapidly colonized numerous European countries following their introduction to the continent in 1950 and 1960, respectively (Kirkendall and Faccoli 2010; Galko et al. 2018; Fiala et al. 2021). Some bark beetles (including some *Hypothenemus* species), even if they are phloeophagous rather than obligate xylomycetophagous, share these characteristics of ecological plasticity, a broad host range, and a high reproductive success (inbreeding, sib-mating reproduction, and sex ratio biased toward females) which allow them to quickly colonize new territories (Mandelshtam et al. 2022).

In Switzerland, Scolytinae are represented by 112 species according to the recent checklist of Sanchez et al. (2020), of which seven species are considered invasive (OFEV 2022): *Cyclorhipidion bodoanum*, *Gnathotrichus materiarius* (Fitch, 1858), *Ips duplicatus* (C. R. Sahlberg, 1836), *Xyleborinus attenuatus* (Blandford, 1894), *Xyleborinus saxesenii* (Ratzeburg, 1837), *Xylosandrus crassiusculus* (Motschulsky, 1866), and *Xylosandrus germanus*. Since this publication, an additional alien species has been recorded in Switzerland: *Anisandrus maiche* (Kurentzov, 1941) (Ribeiro Correia et al. 2023, Preprint), with multiple specimens caught in the southern Alps, in the canton of Ticino. This region is particularly prone to the arrival of new alien species in Switzerland, as has already been shown for other organisms, in particular vascular plants (e.g., Mangili et al. 2016).

Here, we report on three new alien bark and ambrosia beetles species in Switzerland: the two xyleborine ambrosia beetles *Cyclorhipidion distinguendum* (Eggers, 1930), *C. pelliculosum* (Eichhoff, 1878), and *Hypothenemus eruditus* (Westwood, 1834). They were recorded for the first time in 2022 during a comprehensive survey of saproxylic beetles in all major forest typologies and along an altitudinal gradient in the southern Alps, in the canton of Ticino. We discuss the introduction mode, naturalization status, and invasion potential of each species.

Materials and methods

Sampling sites and methods

Saproxylic beetles were sampled at 57 forest sites (study plots) along an altitudinal gradient (195–1,971 m a.s.l.) in the canton of Ticino in the southern Alps, Switzerland, with 114 unbaited Polytrap™ interception traps (Brustel 2012) (Fig. 1). Two traps freely suspended 2 m above the forest floor were placed in each study plot, keeping an intertrap distance of 20–30 m. A saturated salt solution with neutral detergent was used as preserving fluid. The trap contents were collected every two weeks, between early March and the end of September 2022. In addition, one specimen of *Hypothenemus eruditus* was actively captured during a field campaign conducted by the first author in the extreme south of the canton of Ticino, in a wetland forest largely composed of poplars (Fig. 8).

Voucher specimens are deposited at the Museo cantonale di storia naturale (MCSN), at the Swiss Federal Research Institute WSL, and in the personal collections of A. Sanchez and M. Knížek. The data have been deposited in the national database info fauna (www.infofauna.ch).

All specimens were identified morphologically by A. Sanchez and M. Knížek. The identification of *Cyclorhipidion* species was based on criteria provided by Hoebeke et al. (2018) and Smith et al. (2020). Information on the taxonomic status of *Hypothenemus eruditus* was obtained from Kambestad et al. (2017). In addition, two specimens of each species were molecularly identified. The total genomic DNA was extracted from adults using the NucleoSpin Tissue XS Kit (Macherey-Nagel, Düren, Germany) according to the manufacturer's instruction. The COI-Barcode region was amplified and sequenced with standard primers LCO1490 and HCO2198 (Folmer et al. 1994).

To place our Swiss observations within a European context, we considered the distributions proposed by Alonso-Zarazaga et al. (2017, 2023) and the data deposited on the GBIF.org portal (2023), and complemented them with the following publications and the information provided by various European specialists: Great Britain (Turner and Beaver 2015), France (Noblecourt 2004; Dodelin 2018; Barnouin et al. 2020; B. Dodelin pers. comm.), Germany (Gebhardt 2014; H. Gebhardt pers. comm.), Greece (B. Dodelin pers. comm.), Italy (Masutti 1968), Malta (Mifsud and Knížek 2009), Portugal (Marchioro et al. 2022), Russia (Mandelshtam et al. 2018), Spain (López Romero et al. 2007), and Turkey (Tuncer et al. 2017).

Results

Among the more than 28,000 beetles trapped in 2022, 366 specimens were found to belong to three ambrosia and bark beetle species recorded for the first time in Switzerland: 187 females of *C. distinguendum*, 142 females

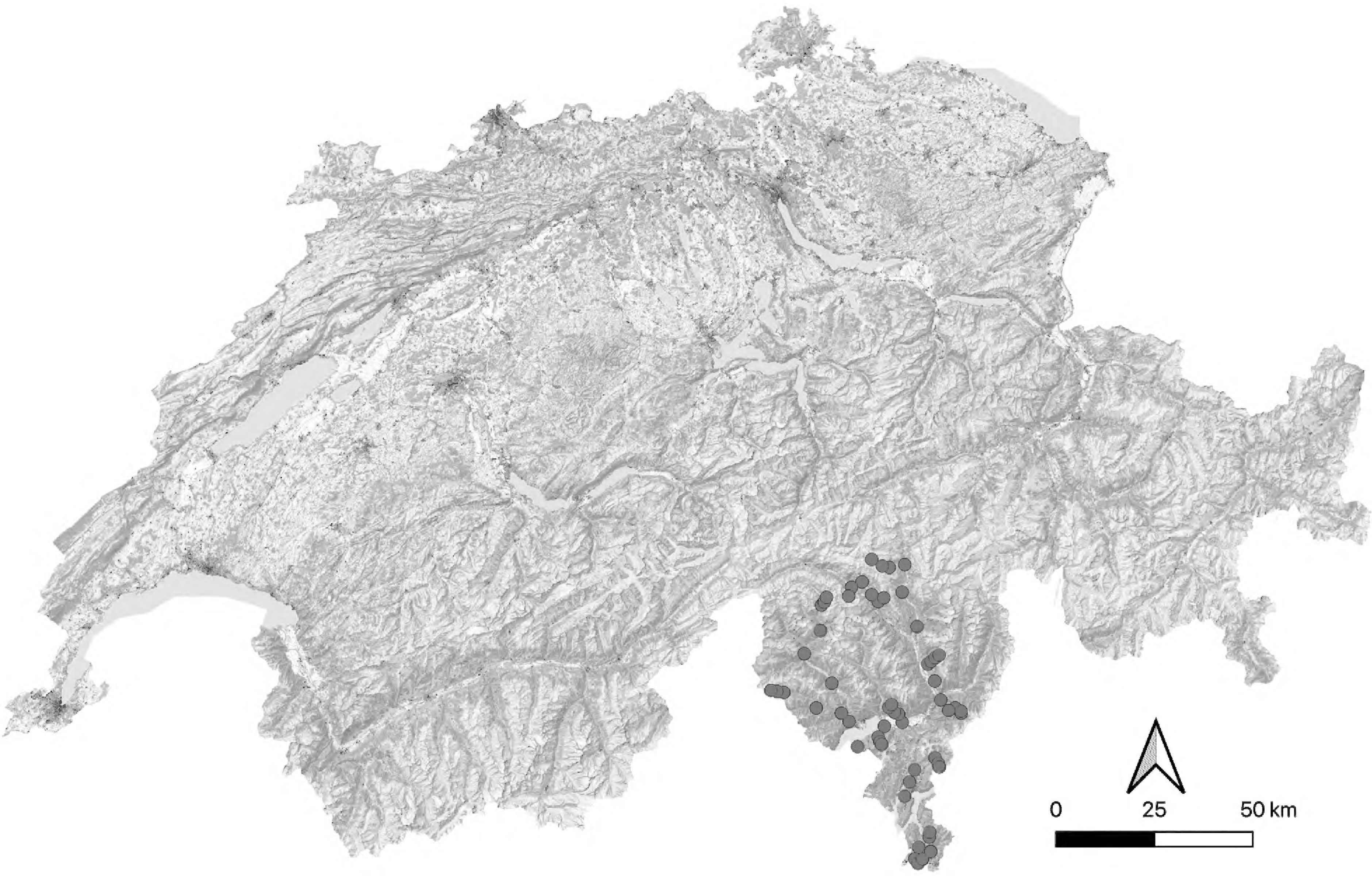

Figure 1. Location of the 114 interception traps (orange dots) in 2022 in the southern Alps, canton of Ticino. (Vector and raster map data swisstopo.ch).

of *C. pelliculosum*, and 37 specimens of *H. eruditus*. The details of the recorded specimens are shown below. If not specified otherwise, the collector (leg.) was the project coordinator D. Frey.

Cyclorhipidion distinguendum (Eggers, 1930)

Figs 2, 3

Switzerland • 1 ♀; Arbedo-Castione, El Gag; 2724273, 1119188 (46.212669245, 9.049077111); 328 m a.s.l.; 10 Apr.–2 May 2022; MCSN. • 2 ♀; Bellinzona, Ruderi del Castello di Claro; 2722751, 1124011 (46.256325540, 9.030627382); 437 m a.s.l.; 14 Jun.–14 Aug. 2022; MCSN. • 49 ♀; Capriasca, Solorónch; 2717643, 1101393 (46.053814854, 8.958714310); 620 m a.s.l.; 2717651, 1101409 (46.053957360, 8.958821658); 626 m a.s.l.; 31 Mar.–5 Sep. 2022; Sanchez A., Knížek M. coll. and MCSN. • 2 ♀; Cadenazzo; Ciossa Antognini; 2714516, 1113409 (8,921253831, 46,162423843); 201 m a.s.l.; 14 Mar.–14 Apr.; MCSN. • 1 ♀; Castel San Pietro, Al Ronco; 2721737, 1080586 (45.865958663, 9.006227205); 510 m a.s.l.; 3–17 May 2022; MCSN. • 1 ♀; Cevio, Ospedale; 2689580, 1130931 (46.323805242, 8.601830413); 426 m a.s.l.; 11–26 Apr. 2022; MCSN. • 13 ♀; Collina d'Oro, Al Lago di Muzzano; 2715093, 1094661 (45.993707761, 8.924126664); 339 m a.s.l.; 2715063, 1094662 (45.993721864, 8.923739798); 339 m a.s.l.; 31 Mar.–12 Aug. 2022; Sanchez A. coll. and MCSN. • 1 ♀; Locarno, Bolette; 2709941, 1112476 (46.154794646, 8.861816697); 195 m a.s.l.; 14–26 Jul. 2022; MCSN. • 11 ♀; Lugano, Ponte Curtina; 2722793, 1104469 (46.080562140, 9.026044051); 676 m a.s.l.; 2722772, 1104459 (46.080476025, 9.025770034); 676 m a.s.l.; 2 May–5 Sep. 2022; Sanchez A. coll. and MCSN. • 7 ♀; Mendrisio, Monte Cristo; 2718662, 1081690 (45.876433372, 8.966918208); 425 m a.s.l.; 2718653, 1081707 (45.876587841, 8.966806589); 438 m a.s.l.; 10 Mar.–17 May 2022; Knížek M. coll. and MCSN. • 2 ♀; Novazzano, In Gall; 2719654, 1078647 (45.848891375, 8.978921620); 293 m a.s.l.; 1 Jun.–12 Jul. 2022; MCSN. • 31 ♀; Novazzano, La Valéta; 2718486, 1077592 (45.839608442, 8.963626081); 445 m a.s.l.; 2718533, 1077578 (45.839474311, 8.964227340); 450 m a.s.l.; 31 Mar.–12 Jul. 2022; MCSN and WSL. • 62 ♀; Vezia, S. Martino; 2716328/1098298 (46.026206809, 8.940961559); 431 m a.s.l.; 2716354, 1098287 (46.026103397, 8.941294533); 414 m a.s.l.; 31 Mar.–3 Oct. 2022; Knížek M. coll., MCSN and WSL.

The morphological identification of *C. distinguendum* was confirmed by the genetic analysis of two specimens (the sequences were deposited on GenBank: accession numbers OQ872230 and OQ872233). A sequence comparison of the COI-Barcode region of 650 and 589 bp to accessions on the nucleotide database of the National Center for Biotechnology Information (NCBI) confirmed the two sequenced specimens as *C. distinguendum*. Both sequences displayed a 100% similarity with a voucher specimen sequence of *C. distinguendum* (accession number: MN183038.1).

***Cyclorhipidion pelliculosum* (Eichhoff, 1878)**
Figs 4, 5

Switzerland • 1 ♀; Capriasca, Solorónch; 2717643, 1101393 (46.053814854, 8.958714310); 620 m a.s.l.; 14 Apr.–2 May 2022; MCSN. • 12 ♀; Castel San Pietro, Al Ronco; 2721737, 1080586 (45.865958663, 9.006227205); 510 m a.s.l.; 25 Apr.–1 Jun. 2022; MCSN and WSL. • 3 ♀; Collina d'Oro, Al Lago di Muzzano; 2715093, 1094661 (45.993707761, 8.924126664); 339 m a.s.l.; 10 Mar.–14 Apr. 2022; Sanchez A. coll. and MCSN. • 1 ♀; Gambarogno, Quinta; 2703119, 1107291 (46.109238055, 8.772383402); 311 m a.s.l.; 11 Apr.–2 May 2022; MCSN. • 14 ♀; Mendrisio, Monte Cristo; 2718662, 1081690 (45.876433372, 8.966918208); 425 m a.s.l.; 2718653, 1081707 (45.876587841, 8.966806589); 438 m a.s.l.; 31 Mar.–17 May 2022; Knížek M. coll., MCSN and WSL. • 13 ♀; Novazzano, In Gall; 2719654, 1078647 (45.848891375, 8.978921620); 293 m a.s.l.; 2719618, 1078694 (45.849320430, 8.978470196); 291 m a.s.l.; 11 Mar.–25 Apr. 2022; MCSN. • 86 ♀; Novazzano, La Valéta; 2718533, 1077578 (45.839474311, 8.964227340); 450 m a.s.l.; 2718486, 1077592 (45.839608442, 8.963626081); 445 m a.s.l.; 10 Mar.–1 Jun. 2022; Sanchez A., Knížek M. coll. and MCSN. • 8 ♀; Stabio, Colombera; 2717648, 1078757 (45.850232009, 8.953132727); 345 m a.s.l.; 31 Mar.–17 May 2022; MCSN. • 4 ♀; Vezia, S. Martino; 2716354, 1098287 (46.026103397, 8.941294533); 414 m a.s.l.; 31 Mar.–2 May 2022; MCSN.

The morphological identification of *C. pelliculosum* was confirmed by the genetic analysis of two specimens (the sequences were deposited on GenBank: accession numbers OQ872231, OQ872232). According to a fragment of 559 and 577 bp, the BLAST searches confirmed the two sequenced specimens as *C. pelliculosum*. The nucleotide sequences showed a 99.6% identity to the oxidase subunit I (COI) gene from *C. pelliculosum* (accession number: GU808702.1).

***Hypothenemus eruditus* (Westwood, 1834)**
Figs 6, 7

Switzerland • 1 ex.; Stabio; Boschi; 715367, 076920 (45.834090180, 8.923328978); 416 m a.s.l.; 18 May 2022; Sanchez A. leg. and coll. • 3 ex.; Collina d'Oro, Al Lago di Muzzano; 2715063, 1094662 (45.993721864, 8.923739798); 339 m a.s.l.; 16 May–1 Jun. 2022; Sanchez A. coll. and MCSN. • 34 ex.; Locarno, Bolette; 2709941, 1112476 (46.154794646, 8.861816697); 195 m a.s.l.; 2709912, 1112488 (46.154907307, 8.861444194); 195 m a.s.l.; 11 Apr.–14 Jul. 2022; Sanchez A., Knížek M. coll., MCSN and WSL.

Despite several attempts on specimens morphologically identified as *H. eruditus*, genetic analyses yielded no results, probably due to insufficient DNA available in such a small specimen or by the deterioration of the DNA by the trap preservation fluid.

Discussion

The use of interception traps for saproxylic beetle surveys often allows the detection of cryptic species. This has, for example, enabled the discovery of several rare species in Switzerland (Sanchez et al. 2021; Chittaro et al. 2023). On the other hand, they can sometimes also allow the detection of new alien species, as has already been the case in Switzerland (Breitenmoser et al. 2022), in France (Dodelin 2018; Barnouin et al. 2020), or in Italy (Marchioro et al. 2022).

The important monitoring (using 114 traps) (Fig. 1) carried out in the canton of Ticino during the summer of 2022 (and reported here) led to the discovery of three new alien species in Switzerland occurring in great abundances, since 366 specimens of these species were captured.

Their ecology, their known distribution in neighbouring countries to date, and the possible threats to the environment associated with their presence are synthesised below.

Cyclorhipidion distinguendum

Cyclorhipidion distinguendum (Fig. 2) is an ambrosia beetle native to Asia, occurring orginally in China (Fujian), India (Uttar Pradesh), Japan, Nepal, Taiwan and Thailand (Chiang Mai) (Hoebeke et al. 2018). In Europe, it was first detected in France in 2013 using interception traps (Dodelin 2018). According to Barnouin et al. (2020) and the new data provided by Dodelin (2018; pers. comm.), it is now established in the country in a small geographical area (Fig. 3), with several specimens having been captured in the last years. However, the circumstances of its introduction remain unknown. It has not yet been reported in other neighbouring countries such as Germany (H. Gebhardt pers. comm.), Austria, or Italy (E. Ruzzier pers. comm.). Despite the monitoring campaigns carried out for many years in northern Italy to detect new alien species (Marchioro et al. 2022; Ruzzier et al. 2022), *C. distinguendum* has curiously not yet been found, even though it is now established in France and Switzerland, particularly close to the Italian borders (Fig. 3). Nevertheless, given that 62 specimens were trapped in 2022 in the extreme south of Ticino, less than 200 meters from the Italian border (latitude/longitude 45.839474311, 8.964227340 and 45.839608442, 8.963626081), the species is almost certainly already present in northern Italy and may soon be detected there as well.

Although its ecology is still poorly known, it seems to preferentially develop on several Fagaceae, Dipterocarpaceae and Pinaceae species, including *Castanea* sp. and *Quercus* sp. (Beaver et al. 2014; Hoebeke et al. 2018; Ruzzier et al. 2023). In France, it was captured «in moist alder mixed forest at low altitude and in beech-fir forests growing at low altitude» (Barnouin et

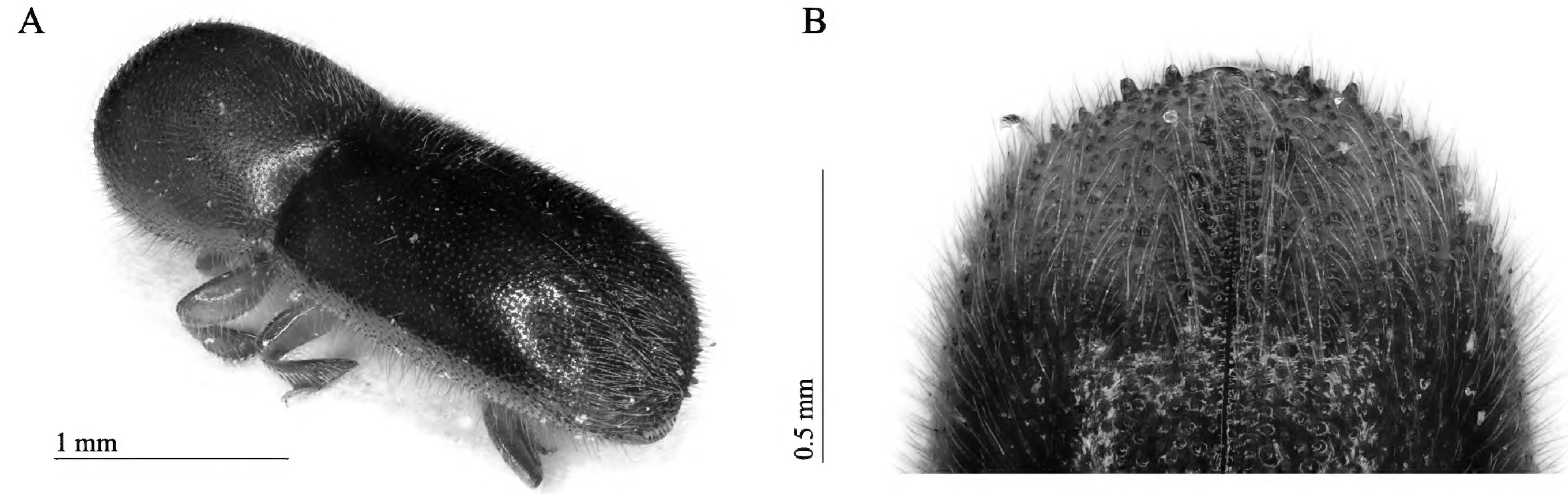

Figure 2. *Cyclorhipidion distinguendum*. **A**. Habitus; **B**. Elytral declivity. (Photos: A. Sanchez).

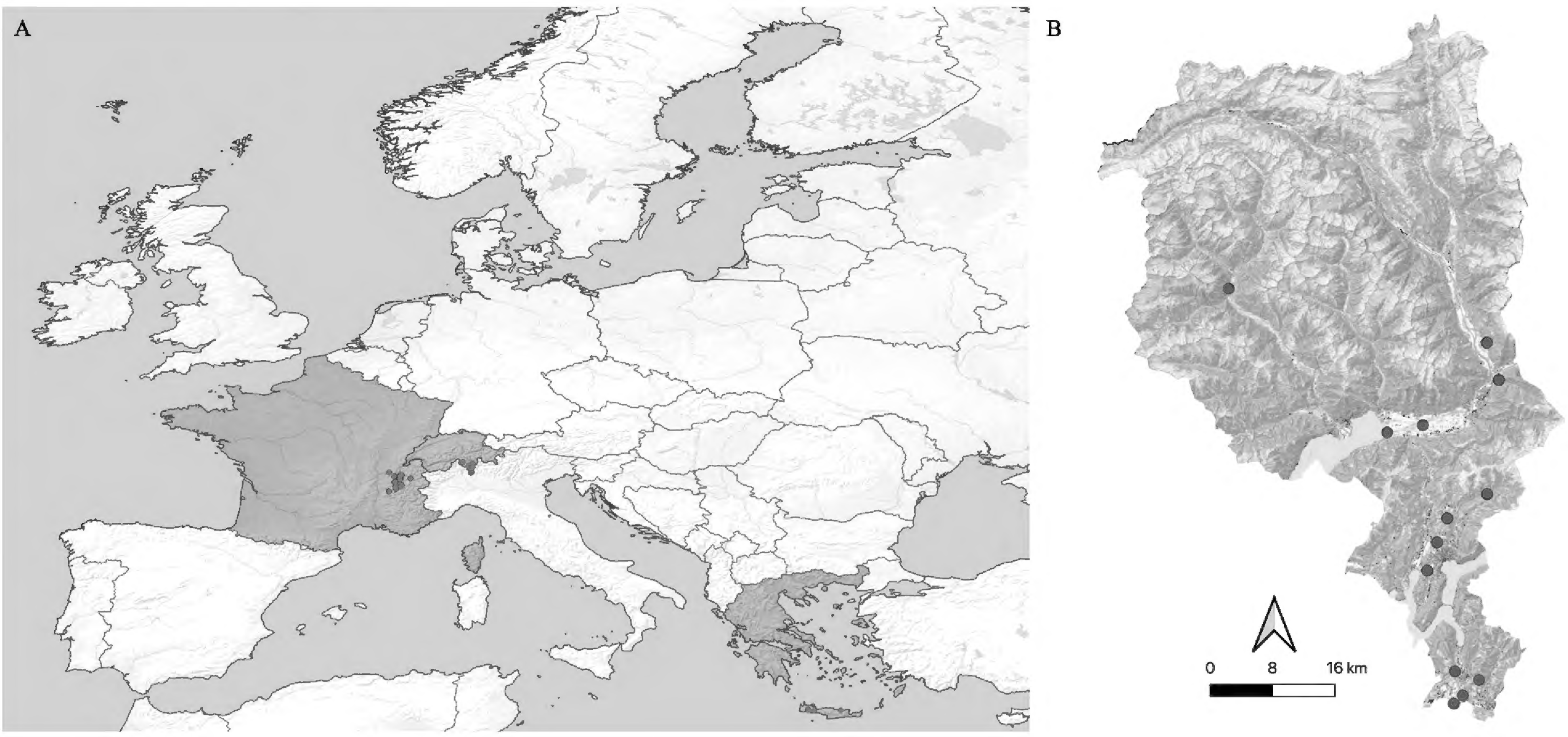

Figure 3. Actual known distribution of *Cyclorhipidion distinguendum* in **A**. Europe (the colonized countries are indicated in blue, and the red dots represent the exact locations of observations) and **B**. Ticino (Switzerland). (Vector and raster map data swisstopo.ch, naturalearthdata.com).

al. 2020). In Switzerland, the species also seems to be restricted to low elevations, with all specimens having been captured in deciduous forests located between 195 and 676 m a.s.l. Since all of these were caught by interception traps, no additional information on the host plants is available. As it has been discovered in multiple locations, the introduction source or locality cannot be reconstructed.

During the summer of 2022, *C. distinguendum* was regularly caught with traps between the 10^{th} of March and the 10^{th} of October, but more than 70% of the specimens were trapped between April and June. Thus, it seems that their peak activity is in spring. This hypothesis has been corroborated by French occurrences (Dodelin 2018; Barnouin et al. 2020).

Until now, no phytosanitary issues have been reported in relation to *C. distinguendum* in France or in the United States (Hoebeke et al. 2018; Barnouin et al. 2020), and this also appears to be the case in Switzerland.

Cyclorhipidion pelliculosum

Cyclorhipidion pelliculosum (Fig. 4) is also native to Asia and is known to occur in China (Fujian), India (Uttarakhand), Nepal and Taiwan (Alonso-Zarazaga et al. 2017, 2023). In Europe, it was first detected in 2013 in the Karlsruhe region in Germany (Gebhardt 2014). Since this first record, it has been found regularly in Germany (in 2017, 2018, 2022) (H. Gebhardt pers. comm.), but it still remains unknown in other countries neighbouring Switzerland. Nevertheless, since 214 specimens of *C. pelliculosum* were trapped in 2022 in the south of Ticino, less than 1 kilometre from the Italian border, it is almost certainly also present in Italy. Its future discovery in France is also very likely, given its presence in Germany near the Franco-German border (Fig. 5).

The first specimen discovered in Europe was found on a poplar (*Populus* sp.) trunk (Gebhardt 2014), while the following German specimens were collected under the bark of a dead standing European beech (*Fagus sylvactica* L.) and

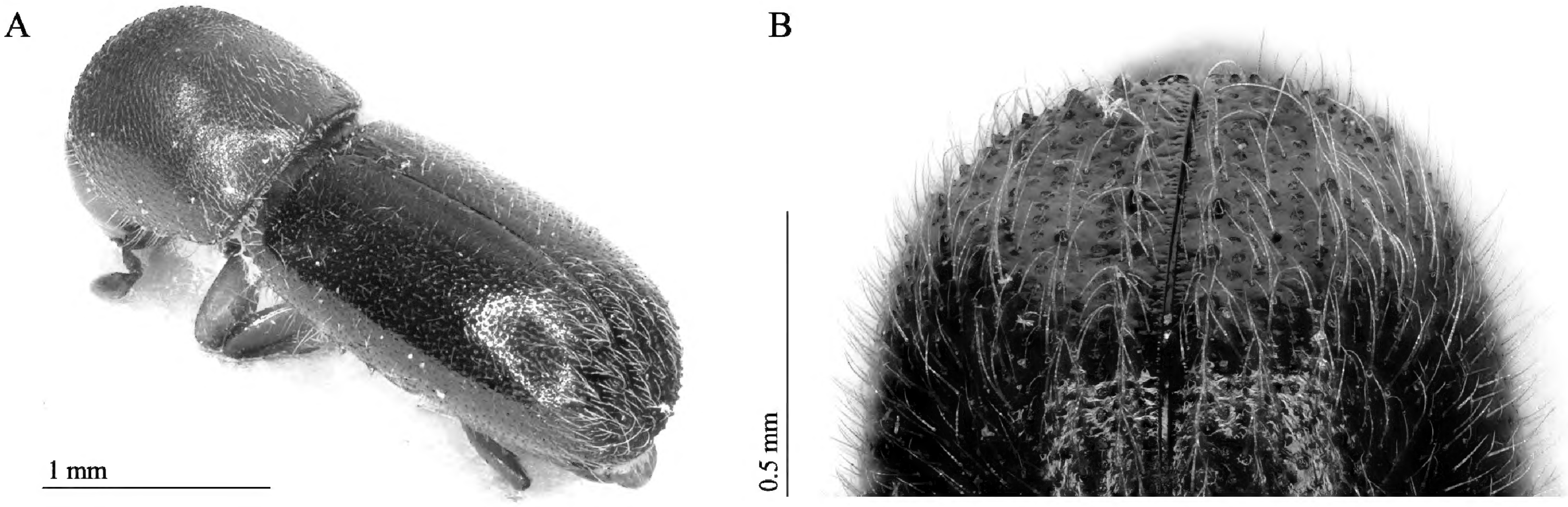

Figure 4. *Cyclorhipidion pelliculosum*. **A**. Habitus; **B**. Elytral declivity. (Photos: A. Sanchez).

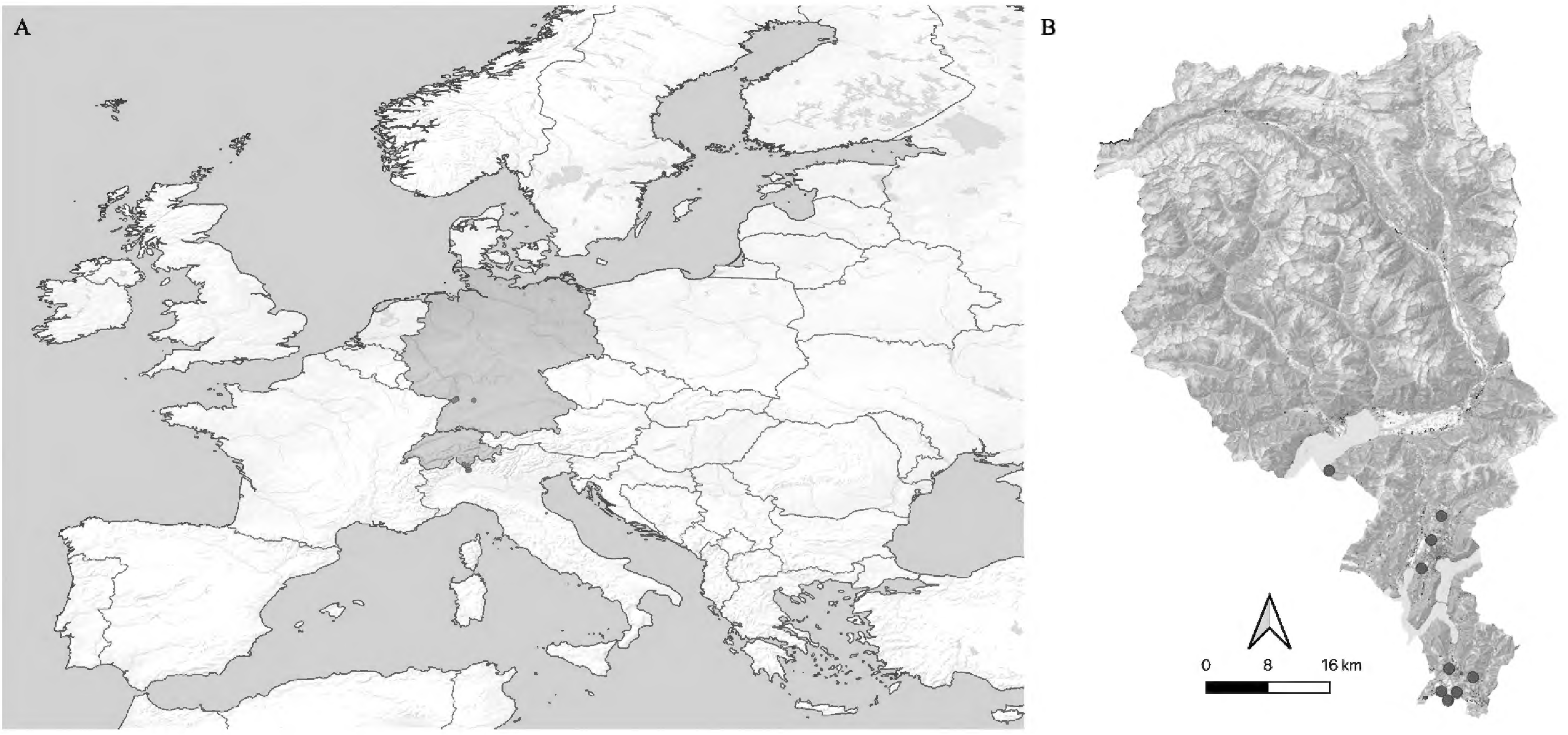

Figure 5. Actual known distribution of *Cyclorhipidion pelliculosum* in **A**. Europe (the colonized countries are indicated in yellow, and the red dots represent the exact locations of observations) and **B**. Ticino (Switzerland). (Vector and raster map data swisstopo.ch, naturalearthdata.com).

on oak (*Quercus* sp.) trunks (H. Gebhardt pers. comm.). Several other host species, including *Acer* sp., *Alnus* sp., *Betula* sp., *Castanea* sp., *Castanopsis* sp., *Juglans* sp. and *Quercus* sp., have been reported in the literature (e.g., in Wood and Bright 1992; Mandelshtam et al. 2018; Smith et al. 2020; Ruzzier et al. 2023). Like *C. distinguendum*, *C. pelliculosum* appears to have a maximum activity in spring and occurs only at low altitudes, a situation also observed in Germany (H. Gebhardt pers. comm.). In Switzerland, the 142 Swiss specimens were all caught between the 10th of March and the 1st of June in deciduous forests located between 291 and 620 m a.s.l. For the moment, no phytosanitary issues attributable to this specis have been noticed in Germany or Switzerland.

Hypothenemus eruditus

Hypothenemus eruditus (Fig. 6) belongs to one of the most diverse scolytine genera in the world, with more than 220 species currently described (Wood 2007; Vega et al. 2015; Huang et al. 2016; Johnson et al. 2020). With more than 70 recognized synonyms (Vega et al. 2015), *H. eruditus* likely represent a complex of several closely related species whose morphological identification is extremely difficult. Extensive genetic studies have shown that several synonyms may be resurrected to valid species in the future (Kambestad et al. 2017). Nevertheless, here we refer to *H. eruditus sensu lato*.

Originally present in tropical and subtropical regions, it is now sub-cosmopolitan and also present in many temperate regions (Vega et al. 2015; Huang et al. 2016). According to several authors, it may even be the most widespread and abundant Scolytinae in the world (Wood 2007; Kambestad et al. 2017). Occurring in Italy since at least 1924 (Ragusa 1924; Kirkendall and Faccoli 2010), it is now established in numerous European coutries (Fig. 7) including Croatia, France, Georgia, Italy, Malta, Portugal (including Azores), Russia, Spain (including Canary Islands), Turkey, and Ukraine (Alonso-Zarazaga et al. 2017, 2023; Marchioro et al. 2022). It was also detected in Britain in 2011 in a «tropical humid biome» with controlled conditions, but the species does not survive there in the wild (Turner and Beaver 2015).

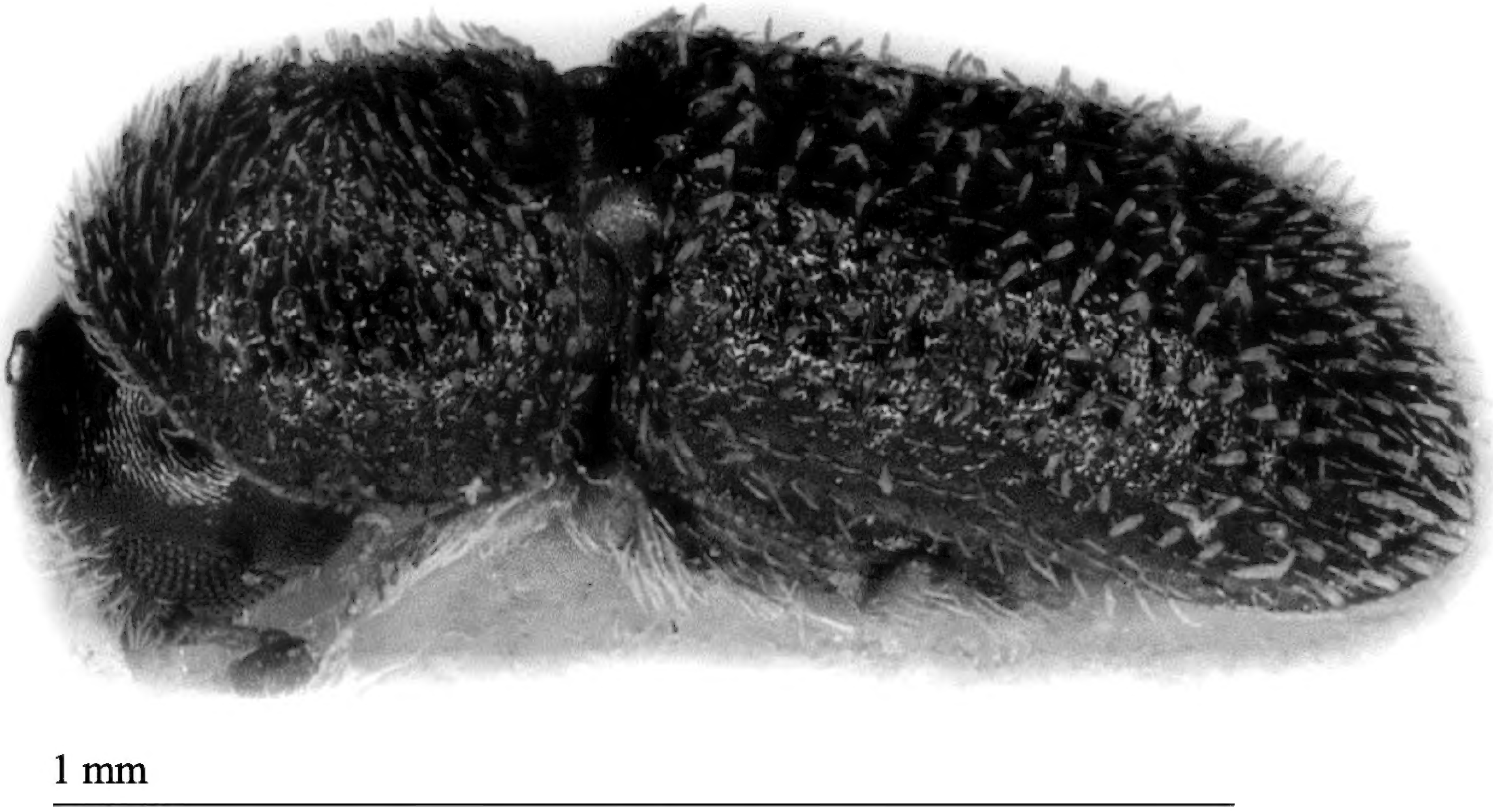

Figure 6. Habitus of *Hypothenemus eruditus*. (Photo: A. Sanchez).

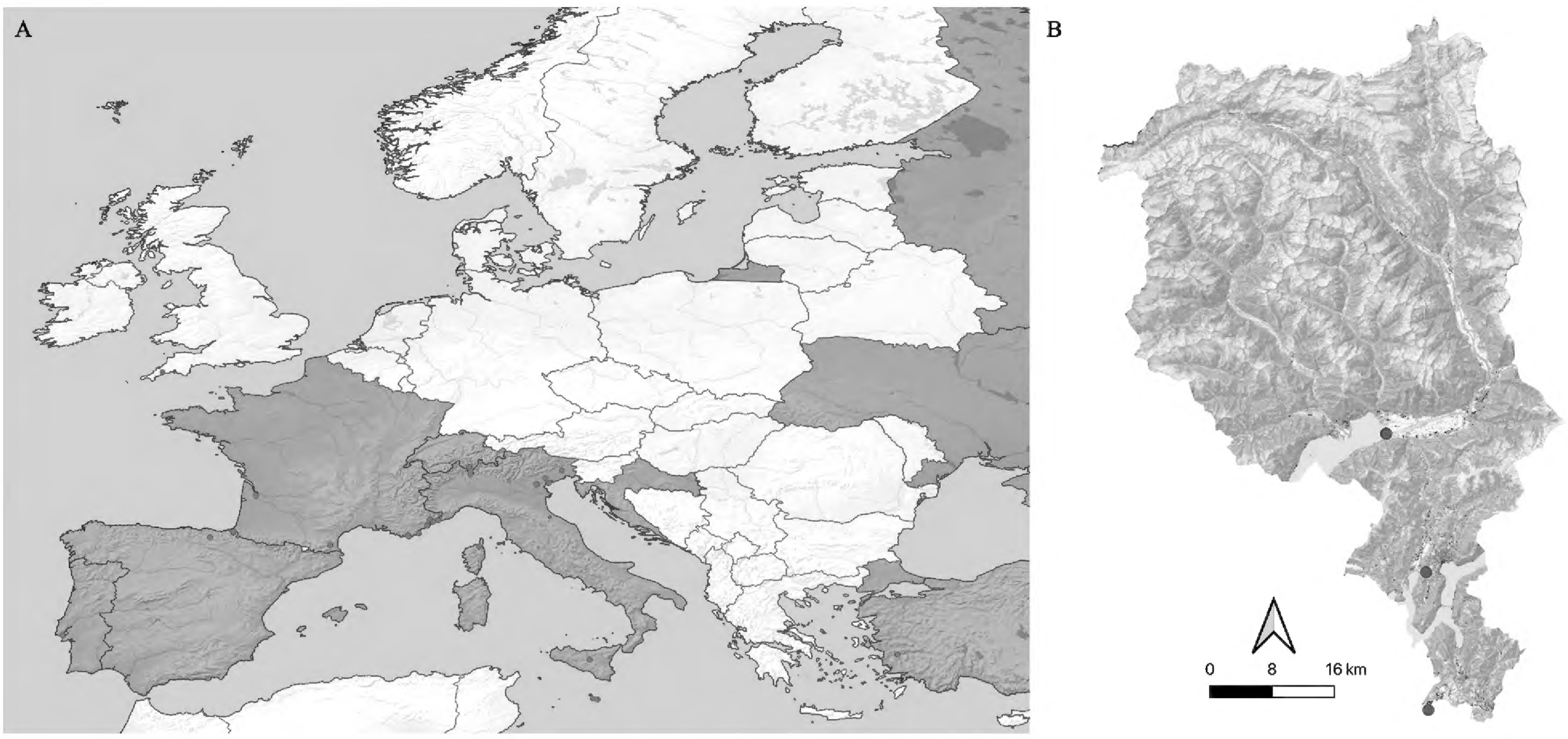

Figure 7. Actual known distribution of *Hypothenemus eruditus* in **A**. Europe (the colonized countries are indicated in green, and the red dots represent the exact locations of observations) and **B**. Ticino (Switzerland). (Vector and raster map data swisstopo.ch, naturalearthdata.com).

Hypothenemus eruditus is an extremely polyphagous species that develops in small branches, but also in the bark of trunks or branches, in flowers, grasses, seeds, leaf petioles, and twigs (Wood 1977; EPPO 2020) of plants (herbaceous, deciduous, and coniferous) belonging to several dozen genera worldwide (Atkinson 2022), as well as in manufactured products (Vega et al. 2015). In Europe, it has been regularly found together with *Hypoborus ficus* Erichson, 1836 (Balachowsky 1949; Noblecourt 2004) on fig trees (*Ficus* sp.) in France (Barnouin et al. 2020), and on mulberry (*Morus alba* L.) in Italy (Masutti 1968). In Switzerland, the first specimen was found in a wetland forest in the extreme south of the canton of Ticino, under the bark of a poplar (*Populus nigra* L.) (Fig. 8). The remaining specimens were all caught by interception traps placed in wetland forests also largely dominated by poplars, a very probable host plant in the region. The 37 Swiss specimens were caught between the 11th of April and the 14th of July, suggesting a period of stronger activity in spring. In France, the species was regularly caught in mid-summer (July-August) (data from GBIF.org), and in Malta, the species was even found in October and in January (one specimen in a dead branch of *Capparis* sp.) (Mifsud and Knížek 2009).

Due to the variety of substrates in which the species can develop, it is difficult to speculate about how it was

Figure 8. The wetland forest in which the first specimen of *H. eruditus* was captured. (Photo: A. Sanchez).

introduced into Switzerland. It is highly likely that the species is already naturalized in Switzerland, given that many individuals have been found in three localities several tens of kilometres apart. The European and Mediterranean Plant Protection Organization (EPPO) drew up a non-exhaustive list of means of transport of the species, including their entry with wood (round or sawn, with bark, including firewood), barks, wood chips, hogwood, wood processing residues (except sawdust and shavings), wood packaging material if not treated, processed wood material (e.g., plywood, veneer), plants for planting, or cut branches of host plants (EPPO 2020).

Despite its highly polyphagous diet, the species does not appear to cause phytosanitary problems in Europe (Huang et al. 2016), even if some authors consider the species to be of potential economic importance (López Romero et al. 2007), in particular as a citrus pest (Mandelshtam et al. 2022).

Occurrence and establishment in Switzerland

These three species were all discovered in Switzerland in 2022, but their already wide known distribution (Figs 3B, 5B, 7B) suggests that they have already been present in the country for several years. Based on the information available to us, these species appear to currently be restricted to the canton of Ticino, the region with the highest number of records of exotic species in the country. The southern part of the canton is certainly their gateway, as has been the case for many invasive species in Switzerland, like other insect species (Derron et al. 2005; Forster et al. 2009; Flacio et al. 2016; EPPO 2017), plants (Schönenberger et al. 2014; Mangili et al. 2016), or fungi (Prospero and Rigling 2012; Beenken et al. 2020). This trend can probably be explained by several factors: on the one hand, this region is a major transit route between northern and southern Europe, with important industrial areas through which many types of merchandise transit and, on the other hand, the mild insubric climate which may facilitate establishment and acclimatization of new species (Mangili et al. 2016). Moreover, this region borders Italy, the country with the highest number of exotic beetles in Europe (Marchioro et al. 2022). Difficult to detect and very polyphagous, these three bark and ambrosia beetle species will probably spread (or be introduced accidentally) in northern Switzerland in the coming years, a situation that has already happened previously with *Cyclorhipidion bodoanum*.

These three new species add to the list of alien Scolytinae that are already widely distributed in Switzerland (list of the invasive species provided in the introduction). Even if the majority of these species are now widely distributed in Switzerland, they do not seem to pose any phytosanitary problems for the moment, at least according to our current knowledge, which is often (very) incomplete (OFEV 2022). Nevertheless, national and cantonal institutions have been informed about the presence of these species in the country, and they will take the necessary measures to monitor the expansion of the species in the canton and the country.

In the last two years, four new alien Scolytinae species (including *A. maiche* (Ribeiro Correia et al. 2023, Preprint)) have been discovered in Switzerland, and new others will certainly be found in coming years. For example, *Xylosandrus compactus* (Chapuis & Eichhoff, 1875) is a potential invader. This species was found for the first time in Europe in Italy in 2011 (Garonna et al. 2012) and is now also present in France (Barnouin et al. 2020). However, in these two countries, it currently remains confined to the Mediterranean region, but global climate change may help this species to expand its distribution, as predicted by some distribution models (e.g., Urvois et al. 2021). *Xyloterinus politus* (Say, 1826) is another species that could become established in Switzerland in the future: it is already present in the Seine-Maritime department in northwestern France (Dodelin and Saurat 2017; Barnouin et al. 2020) and in Bavaria, Germany (Gebhardt and Doerfler 2018). Although these two species have been recorded in neighbouring countries at significant distances from Switzerland, the rapid colonization abilities of these species could lead them to reach the country in the coming years. Fortunately, not all alien species become established in Switzerland. For example, *Coccotrypes dactyliperda* (Fabricius, 1801), *Dactylotrypes longicollis* (Wollaston, 1864), or *Pagiocerus frontalis* (Fabricius, 1801) were accidentally introduced into Switzerland, but there is currently no evidence that these species have reproduced in the wild (Sanchez et al. 2020).

The intensive monitoring campaigns carried out in 2022 revealed new alien and potentially invasive species in Switzerland. This shows the importance of such campaigns, especially in Ticino, for quickly detecting the presence of new species in the territory, and thus allowing necessary measures to be taken to eradicate their expansion, if necessary and if possible. Concerning bark and ambrosia beetles, the monitoring campaigns should ideally be conducted in important transit areas of goods, ideally near the borders and in the airports, as is currently done in France and which has allowed the detection of *Xyloterinus politus* (Dodelin and Saurat 2017), or in cities or suburban areas, where most alien species are detected (Branco et al. 2019). Moreover, to evaluate the progression of these three species in Switzerland, monitoring campaigns should be carried out in other regions of the country.

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